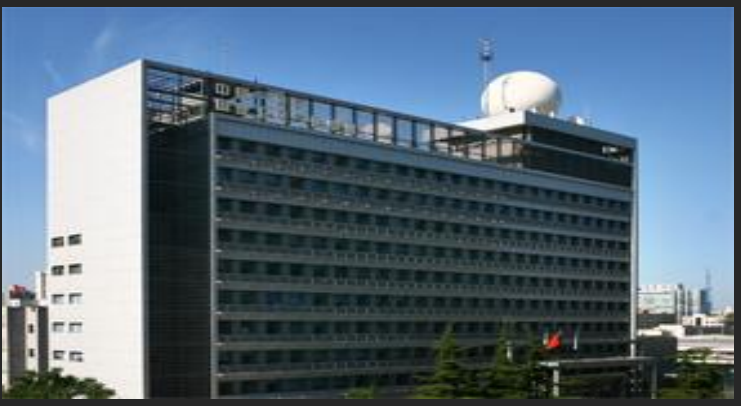
Current Status and Future Plan of Fengyun Meteorological Satellites



ZHANG Xingying

(zxy@cma.gov.cn)

National Satellite Meteorology Center （NSMC）
China Meteorological Administration （CMA）

2020 Community Meeting on NOAA Satellites
September 29 - October 2, 2020

NSMC

Outline

- Fengyun Program Overview
- Current Status and Services
- Latest Progress
- Future Programs

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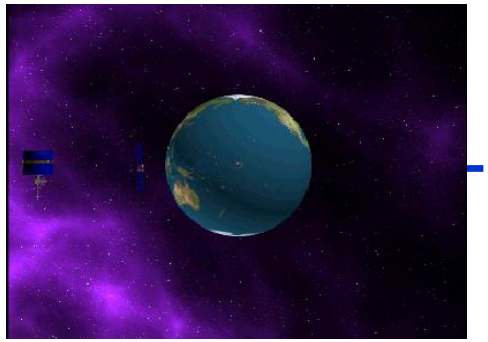
1. Fengyun Program Overview

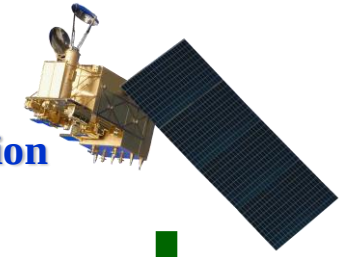
FENGYUN Satellite Family

Polar System

First Generation
FY-1 A, B, C, D

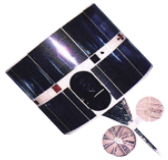


Second Generation
FY-3 A, B, C, D

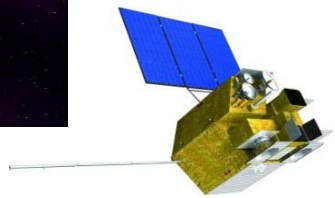


FY-3E, F, G, H planned until 2025

Geo. System



First Generation
FY-2 A, B, C, D, E, F, G, H



Second Generation
FY-4A

FY-4B,C planned until 2025

Launched Satellites

Since Jan. 1969, China began to develop his own meteorological Satellite				
Leo	Launch Data		Geo	Launch Data
FY-1A	Sept. 7, 1988		FY-2A	Jun. 10, 1997
FY-1B	Sept. 3, 1990		FY-2B	Jun. 25, 2000
FY-1C	May 10, 1999		FY-2C	Oct. 18, 2004
FY-1D	May 15, 2002		FY-2D	Dec. 8, 2006
FY-3A	May 27, 2008		FY-2E	Dec. 23, 2008
FY-3B	Nov. 5, 2010		FY-2F	Jan. 13, 2012
FY-3C	Sept. 23, 2013		FY-2G	Dec. 31, 2014
FY-3D	Nov. 15, 2017		FY-4A	Dec. 11, 2016
			FY-2H	Jun. 5, 2018

Overall Development Strategy (4 stages):

1) 1970 - 1990: Conducting satellite research and development
2) 1990 - 2000: Implementing transition from R&D to operational
3) 2000 - 2010: Implementing transition from 1st generation to 2nd generation
4) 2010 - 2020: Pursuing accuracy and precision of satellite measurements

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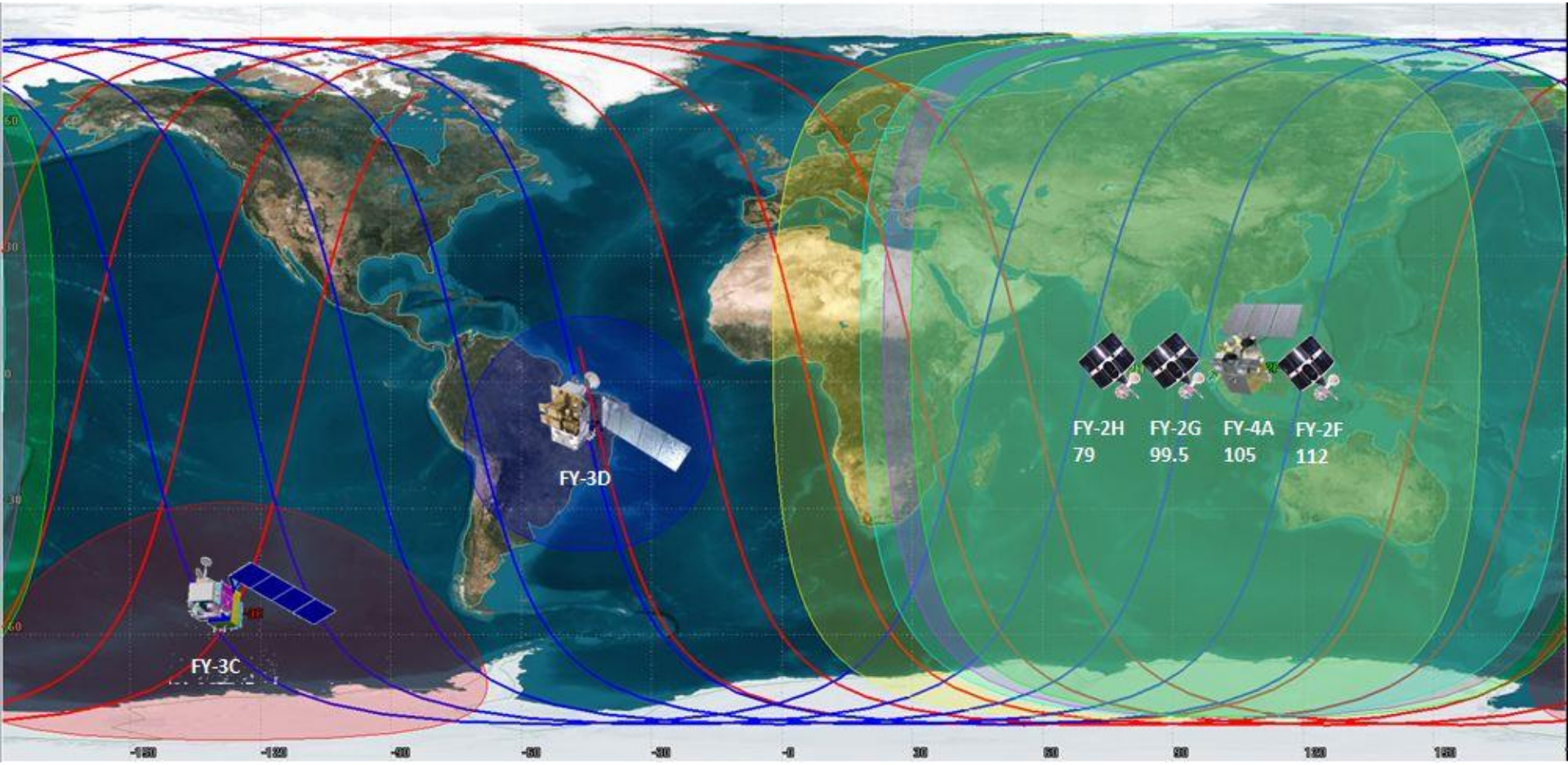
2. Current Status and Services

6 Fengyun satellites operating in orbit



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Global Data Receiving Network of Fengyun Satellites

Domestic：Beijing, Guangzhou, Urumqi, Jiamusi and Kashgar, 5 ground stations

The Antarctic Pole：TrollSat station, Norway

The Antic Pole：Kiruna station, Sweden

Global data access time is better than 2 hours.


北京地面站

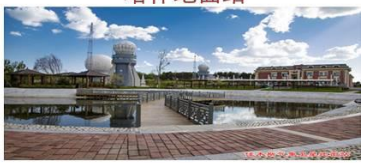

广州地面


乌鲁木齐地面站


资料处理中心


瑞典基律纳地面站


喀什地面站


佳木斯地面站


南极地面站

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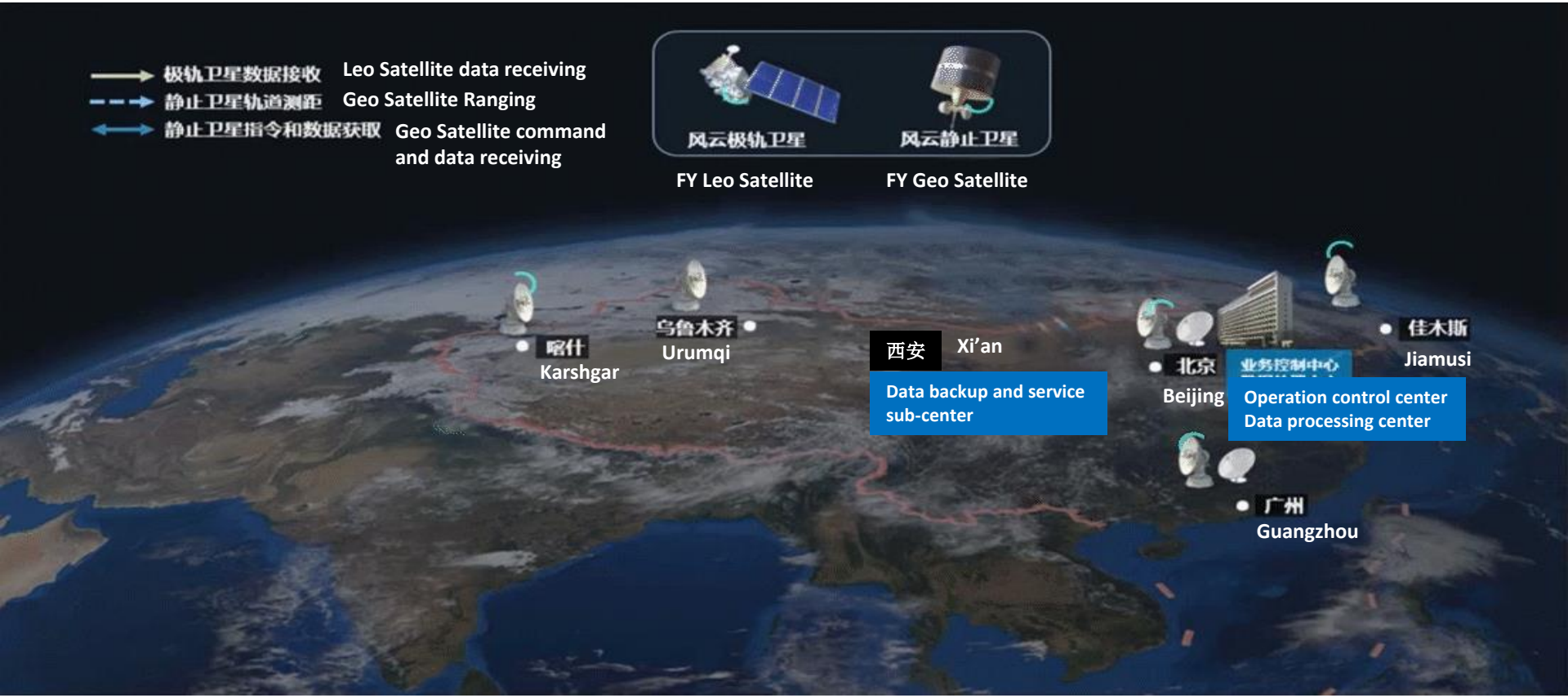
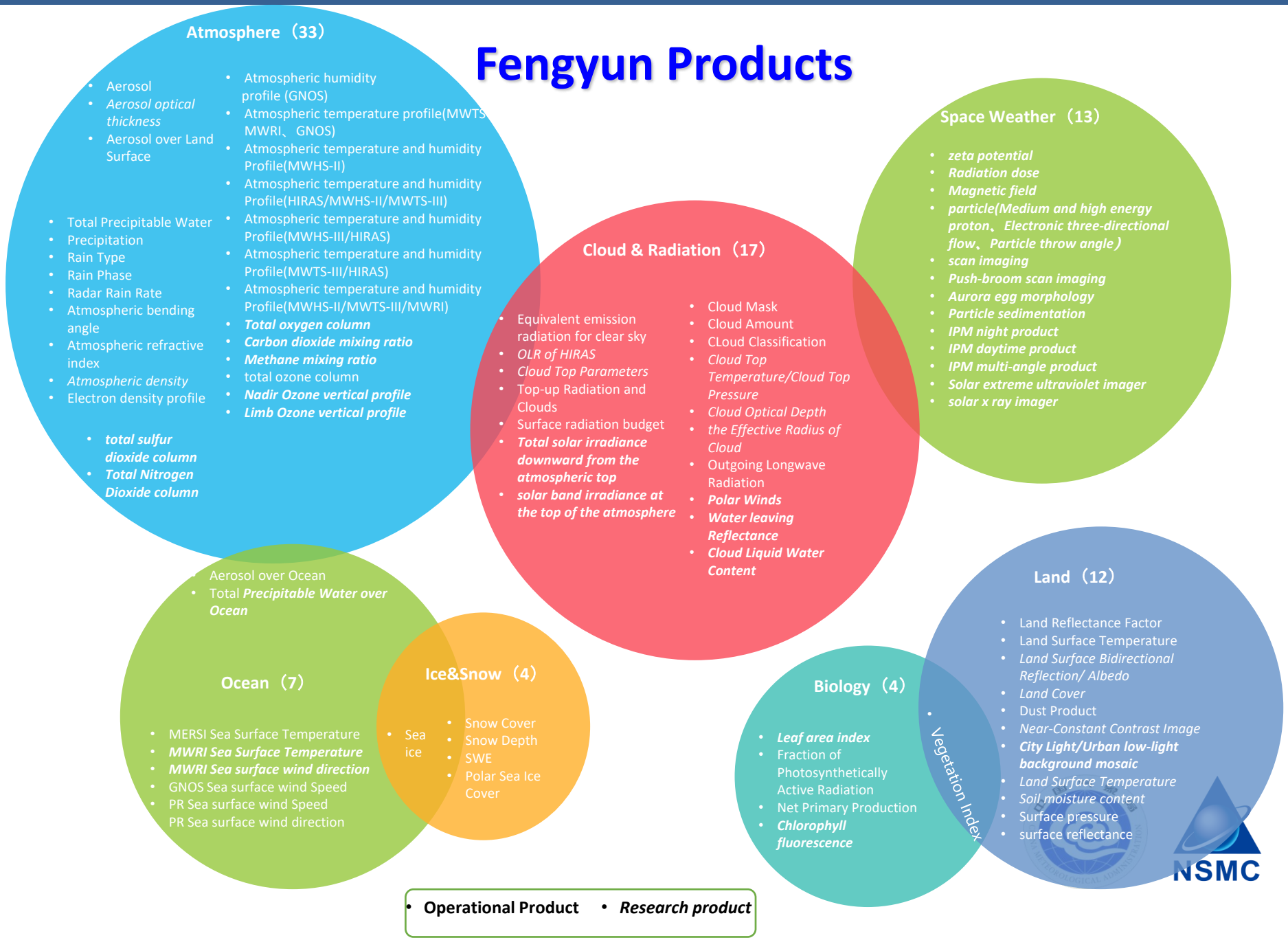
Layout of FY Ground Segment



Fengyun Products



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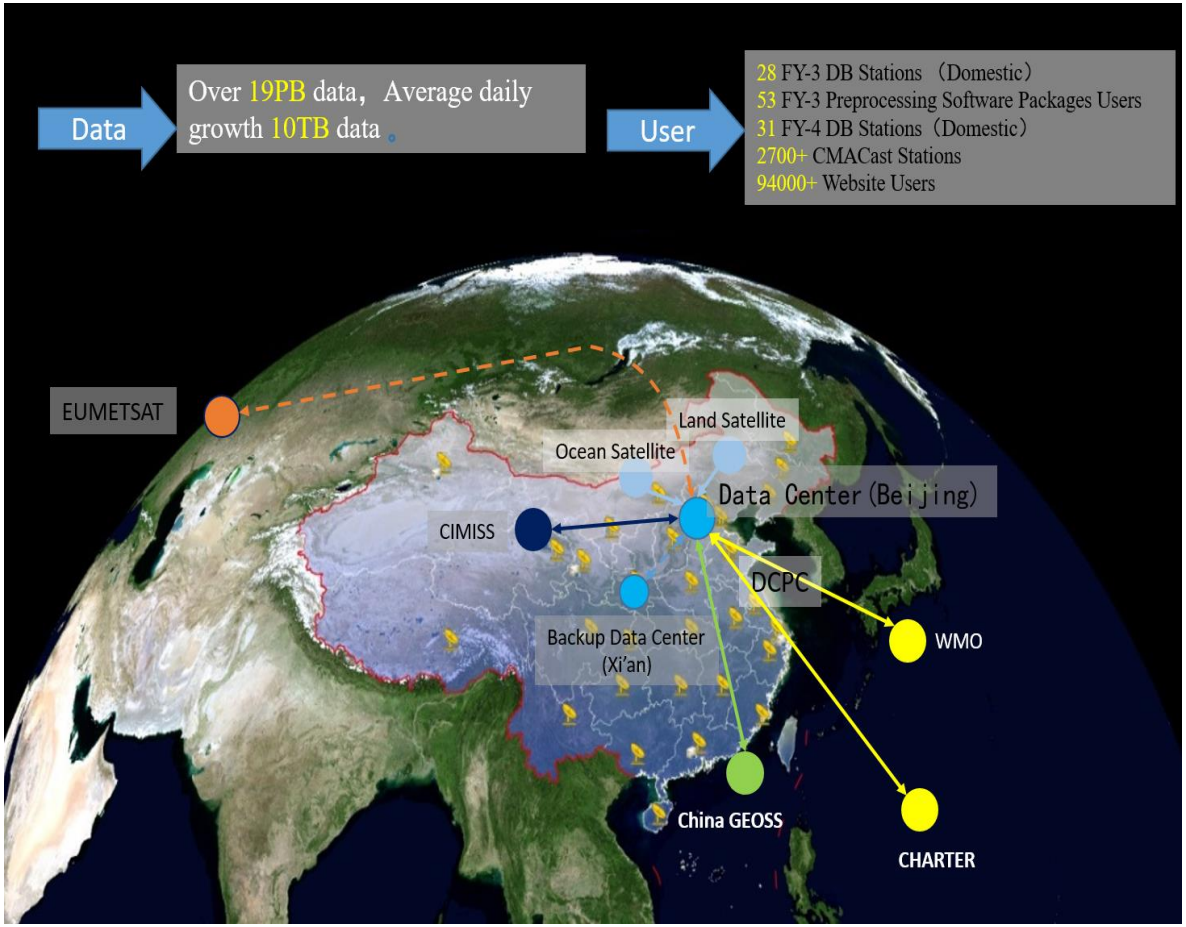
FENGYUN Satellite Data Sharing and Service Capability

NSMC:

One of the largest satellite data sharing centers in China.

Over 19PB data, Average daily growth 10TB data, Total data services about 5.4PB in 2019.

Global Openness, Real-time Sharing



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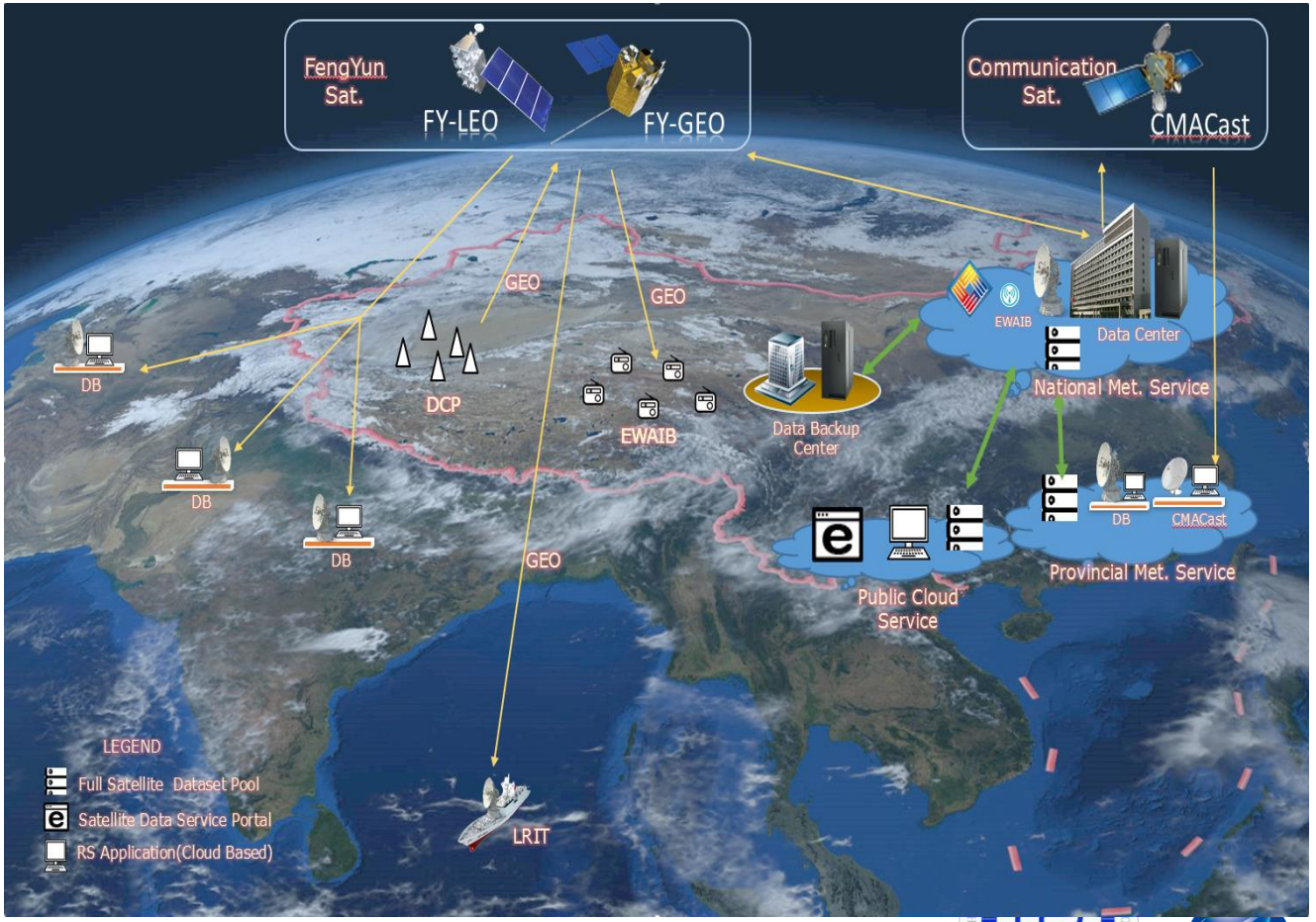
Integrated Space and Ground Based FY Satellite Data Service System

- Real time
  - Direct Broadcast
  - CMACast
- Non-Real Time
  - Website
  - Cloud Service
  - FTP Service
  - Manual Service



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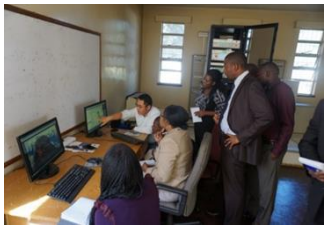
Fengyun Data and Products Service

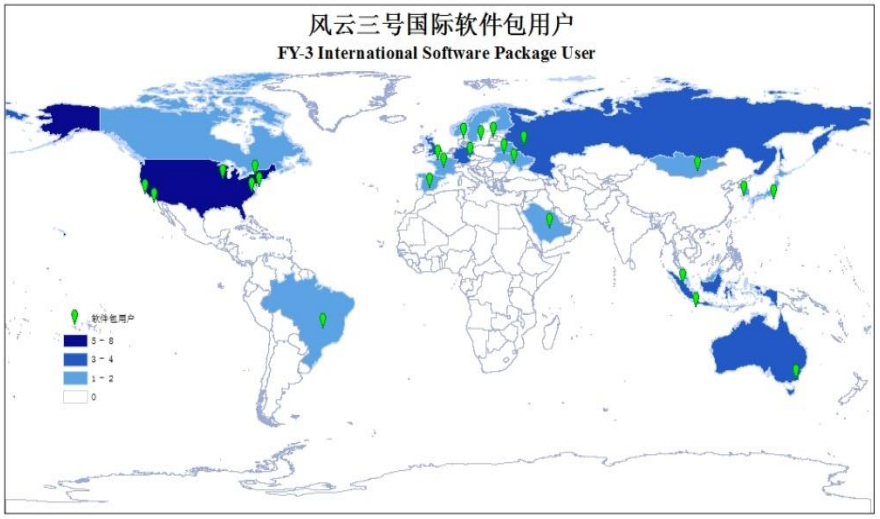
Services	Countries
Fengyun Data Center	108 countries，including 75 Belt & Road countries
Fengyun Direct Broadcasting Station (DB)	35 countries (6 FY-2 DB Station, 2 FY-3 DB Stations, 53 FY-3 Preprocessing Software packages users from 29 countries)
CMACast Stations	20 countries
SWAP 2.0 Website and Stand-alone	58 countries
Direct Data Download users	30 countries
FY_ESM members	29 countries

Space-based Services

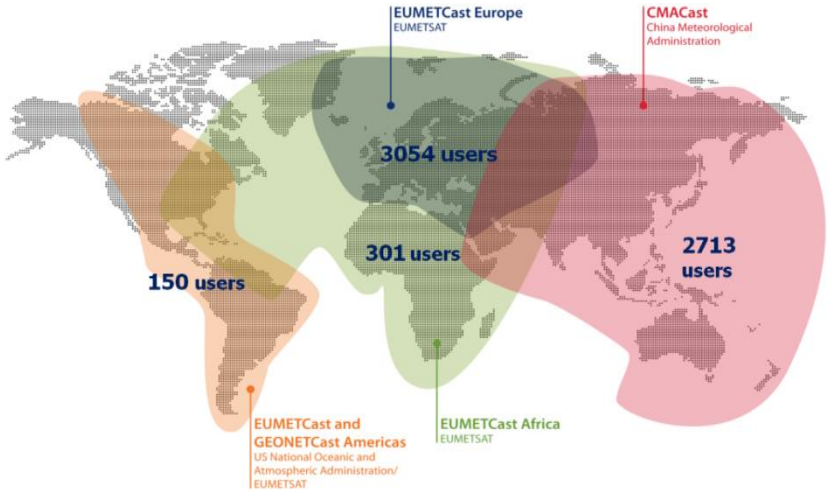


- Over **2700** DVB-S users
- Over **500** Utilization Stations of Geostationary Meteorological Satellite
- Over **3000** Data User Terminals
- Over **billions** people viewing Satellite Cloud Images through TV and Internet
- Over **100** countries and regions

FENGYUN DB Users (29 countries)



CMACast Users (20 countries)



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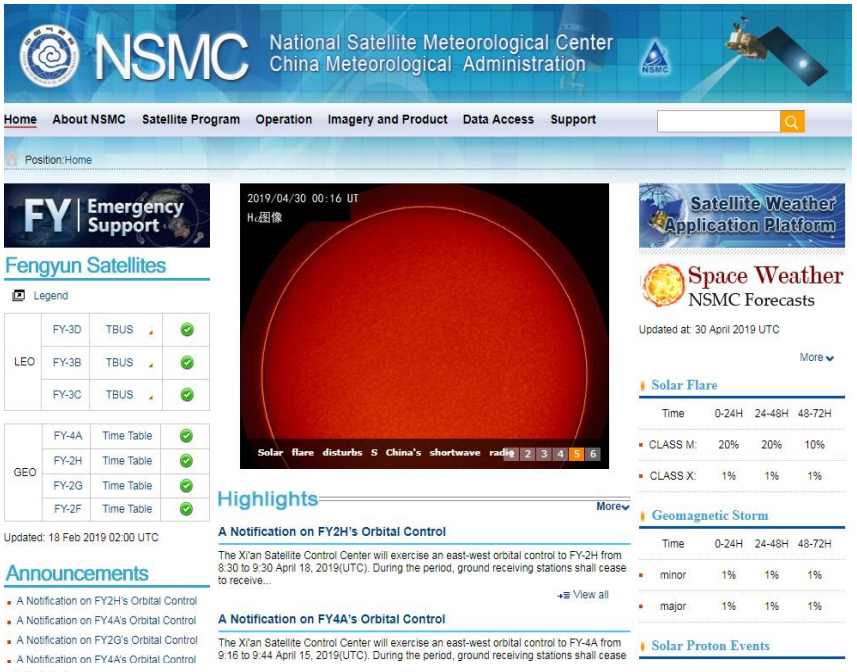
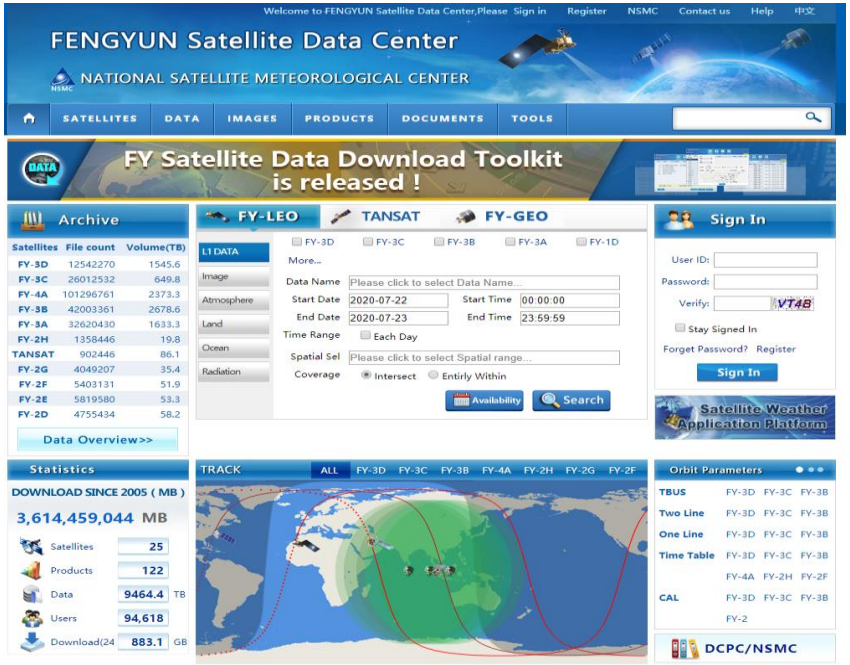
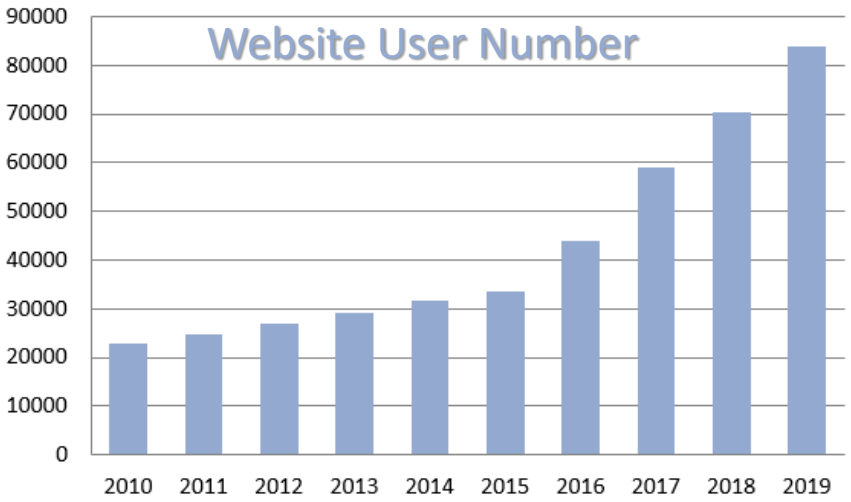
Web Portal Service

http://www.nsmc.org.cn/en



http://data.nsmc.org.cn





Application Tools

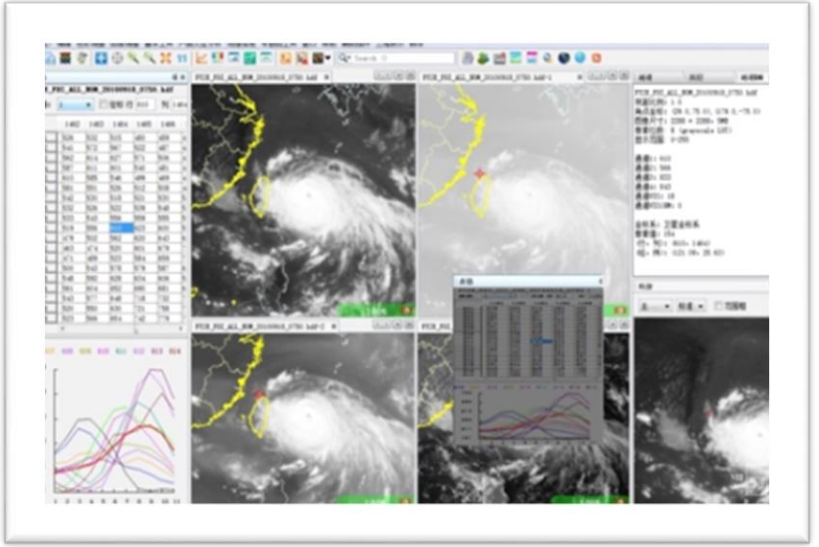
SATs: New Observation Capability

Users: New Applications

Application tools

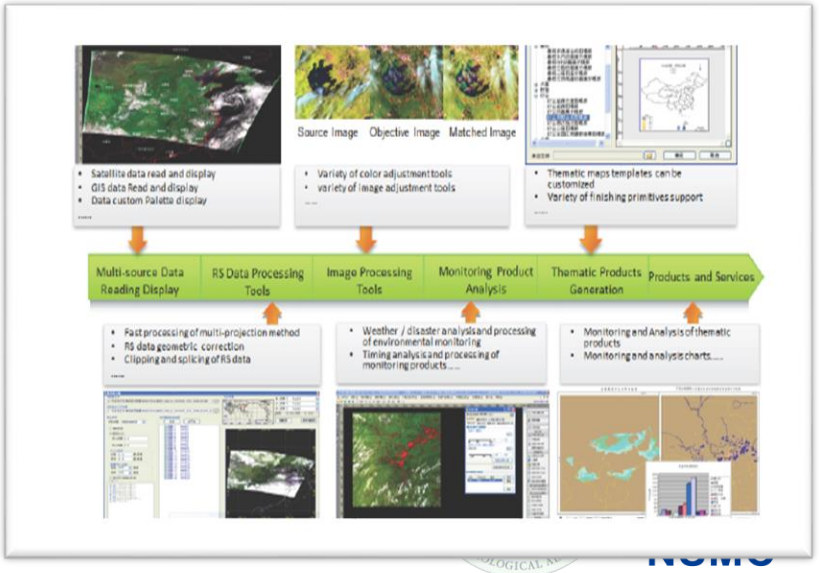
Weather monitoring and analysis
---Geostationary Satellite data (FY-2/FY-4)

Satellite Weather Application Platform
SWAP



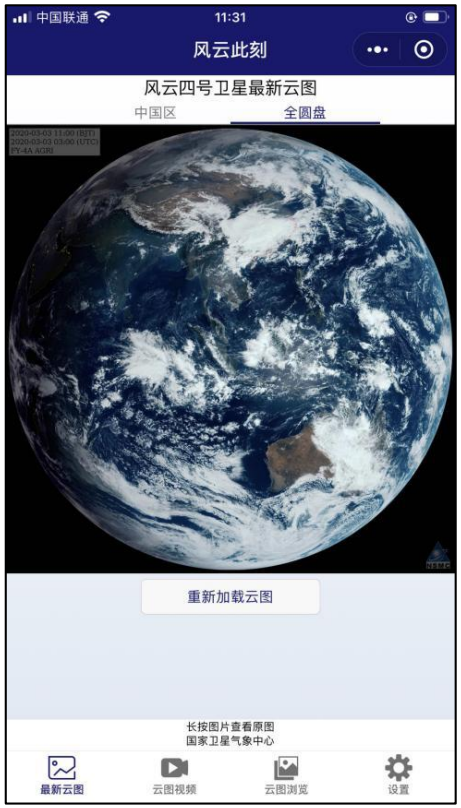
Natural disaster and environment monitoring and analysis
---Polar orbiting Satellite data

Satellite Monitoring Application Remote sensing Toolkit
SMART



- NSMC has launched 2 mobile applications on WeChat platform in 2018, **FengYun Earth View** for LEO satellites and **FengYun Live** for GEO satellites.

FengYun Earth View WeChat Applet release the latest 7 days global true color earth image captured by the MERSI-II instrument onboard FY-3D.



FengYun Live WeChat Applet shows the time-series live cloud images taken by AGRI onboard FY-4A.

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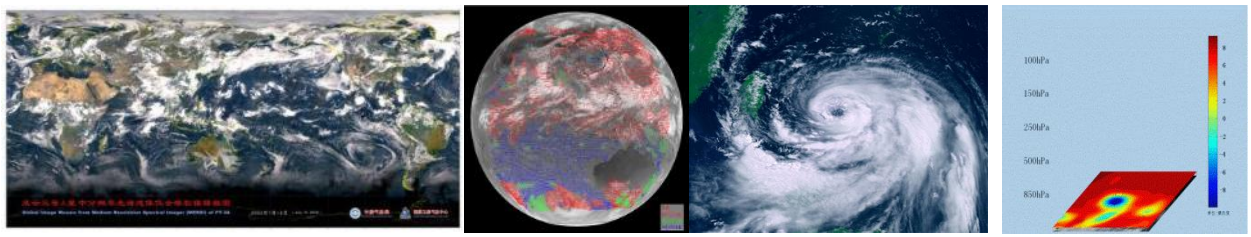
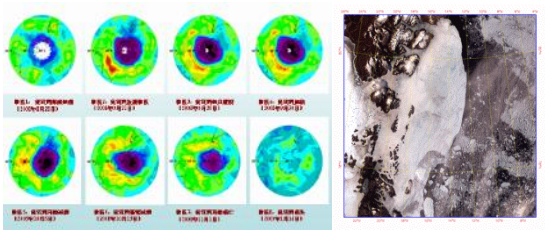
Fengyun Applications

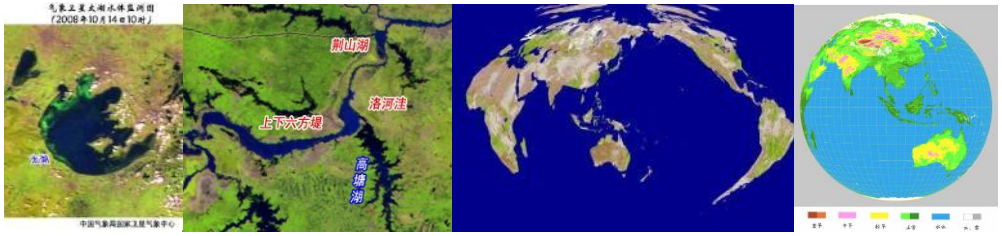
Weather



Climate

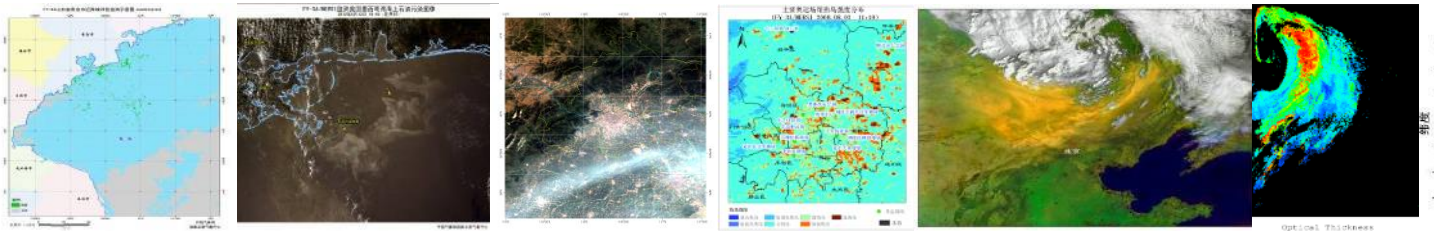


Resource



Disaster

Environment



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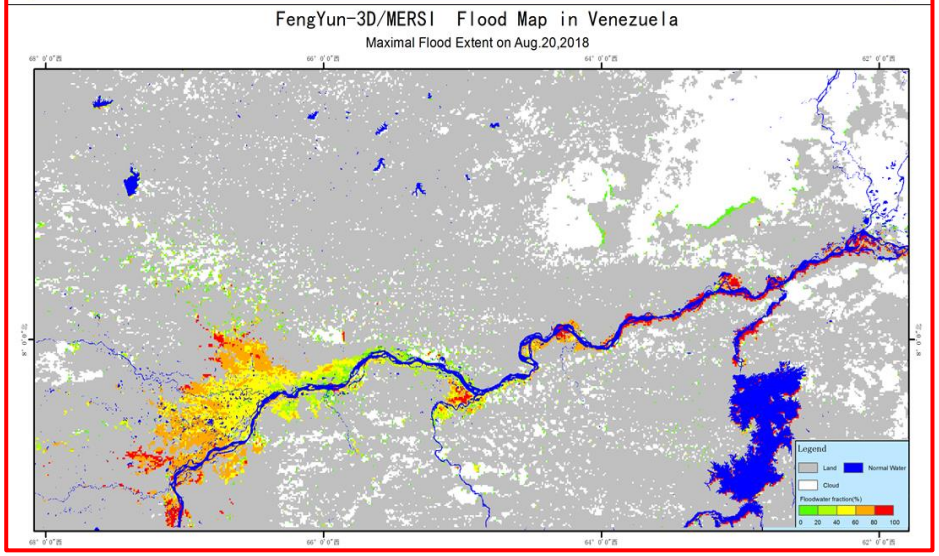
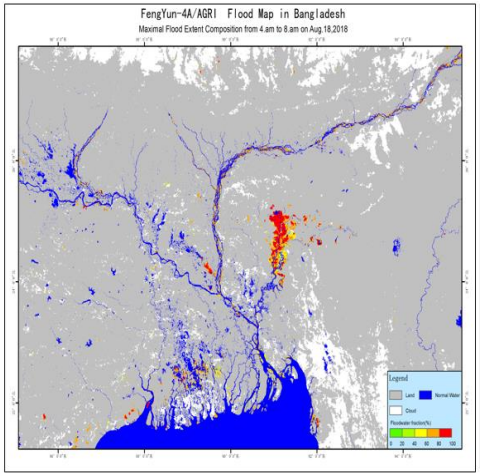
FY-3D monitoring flood in Venezuela

The flood of Venezuela in August of 2018 was monitored based on FY-3D data. The different colour represent the different water fraction value.

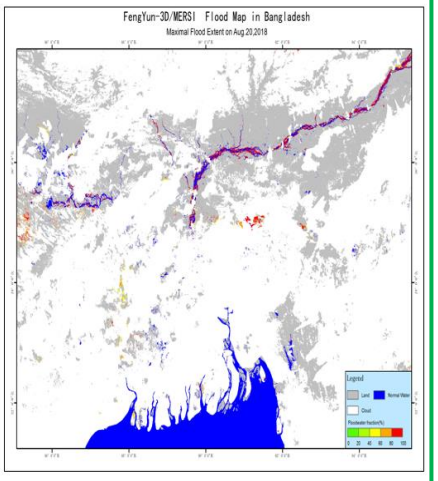


FY-3D and FY-4A monitoring flood in Bangladesh

The flood of Bangladesh in August of2018 was monitored based on FY-3D and FY-4A data.

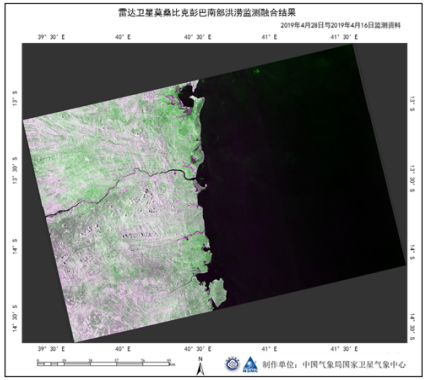


The spatial distribution information of flood can be obtained by using the 1 km resolution FY-4 satellite at 12:00-16:00.



The flood was monitored by the 250m spatial resolution data of FY-3D, showing more refined river water distribution, but less clear sky area.

Monitoring flood using high spatial resolution satellites



Super typhoon Kenneth landed on the coast of Cape Delgadou Province in northern Mozambique around 2230 hours on April 25, causing floods in northern Mozambique.

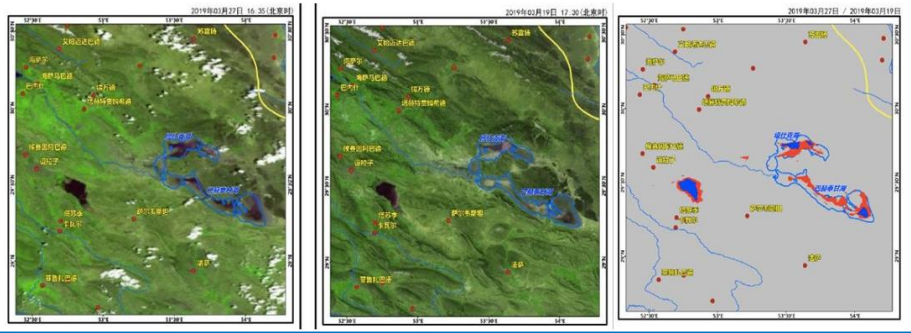
The results of Sentinel-1 data fusion on April 28, 2019 and April 16, 2019 show that a number of rivers in Cape Delgadou and Nampula provinces have enlarged their water bodies. The widening of the Lurio River is obvious . It is estimated that the expanded water area in the above-mentioned areas is about 185 square kilometers .

FY-3D monitoring flood in Iran's southern province

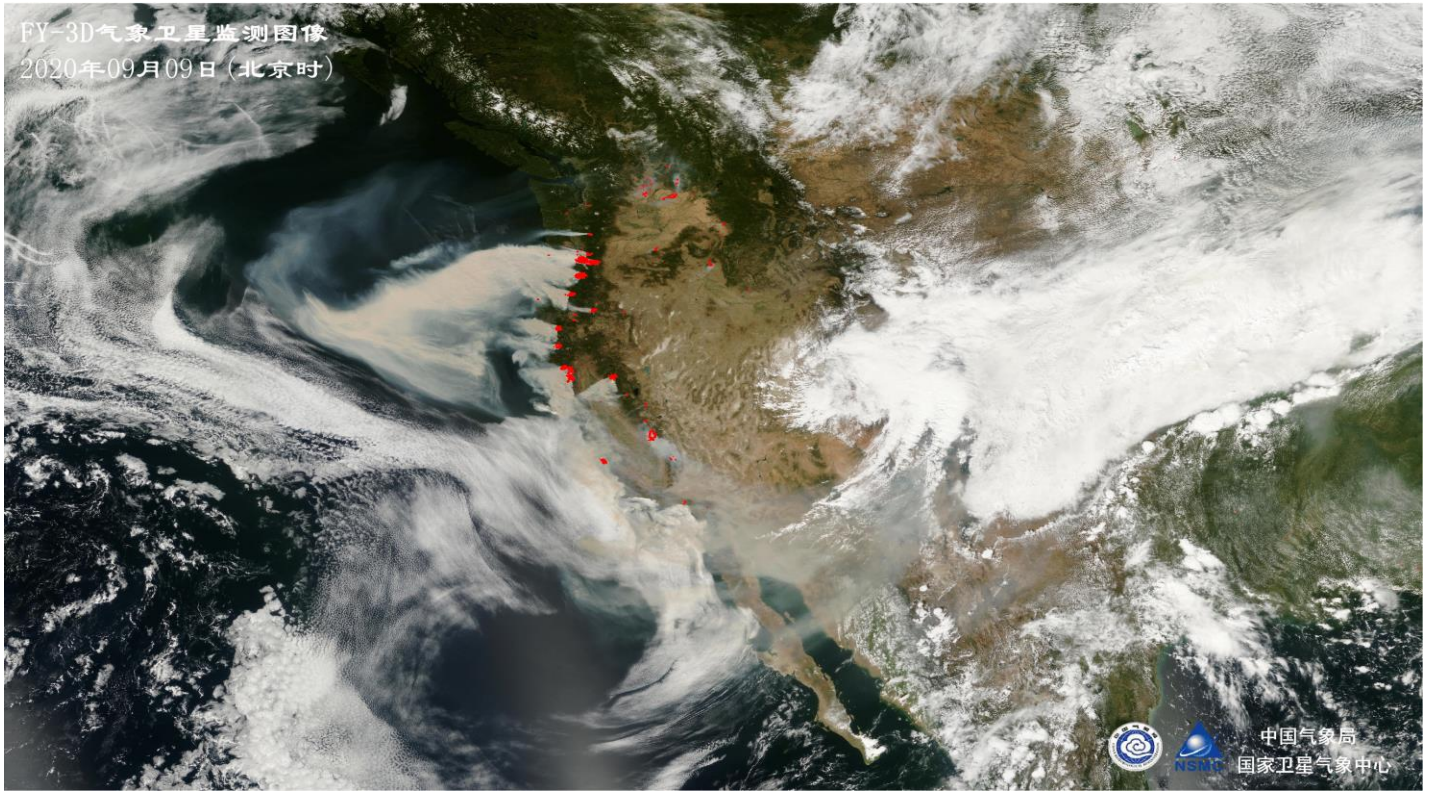
There were flash floods in Iran's southern province of Fars on 25 March, following devastating floods in the north.

Flood map using FY-3D showed that in the southwestern Iran, the range of water body of the Lake Tashk and Bakhtaigan Lake has increased.

It is estimated that the impact of floods in the above areas is about 350 square kilometers, an increase of about 36%.



FY-3 D mornitoring fire in US



In late August 2020, a rare wildfire occurred in the western United States. According to the monitoring of FengYun-3D satellite, a large area of fire occurred along the west coast of the United States in September. The smoke diffused outward obviously, which affected the Pacific ocean, southern and northern parts of the United States. The Aerosol Optical Depth (AOD), Aerosol Index, NO_2, CO is high in the polluted aeras.

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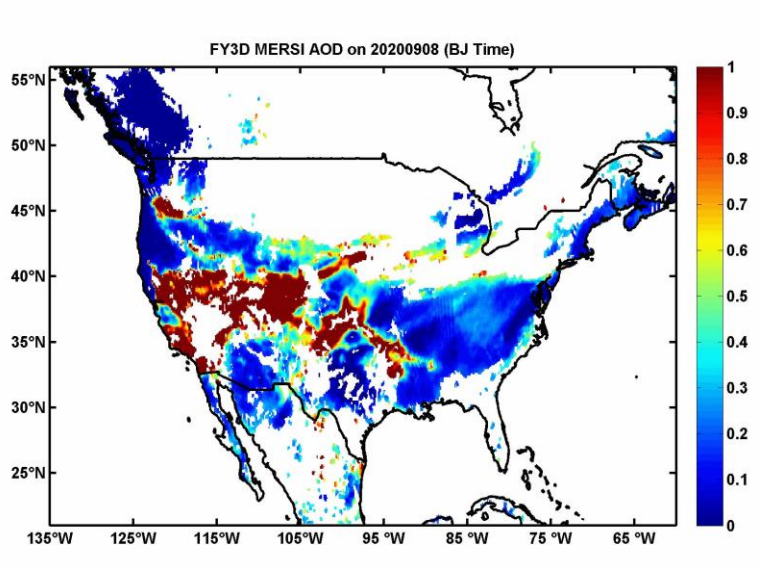
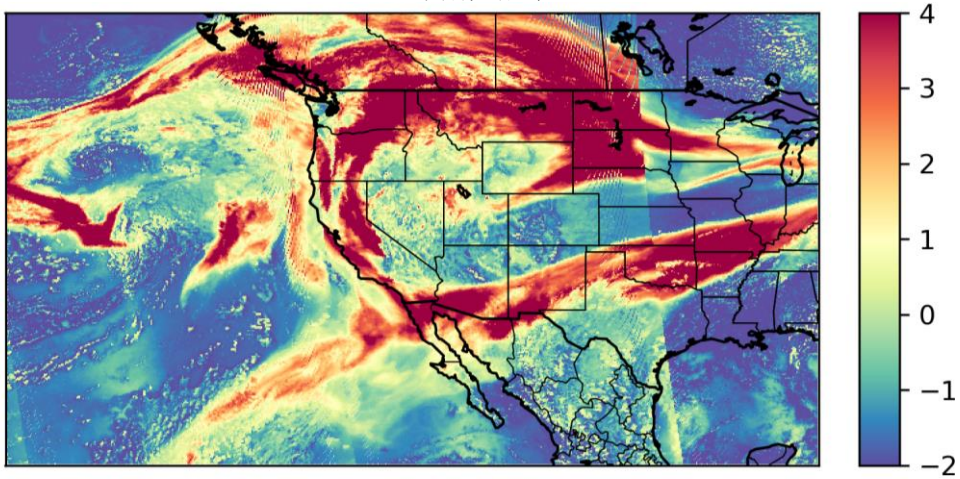
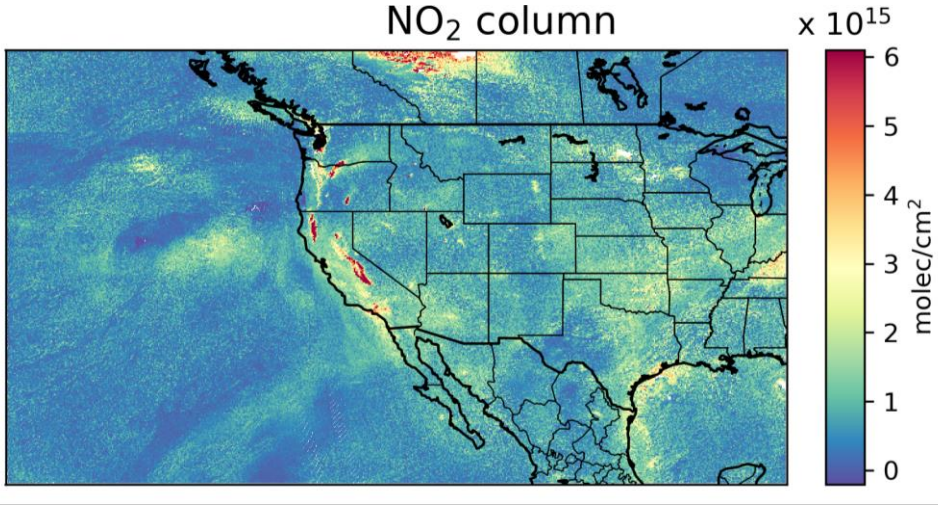
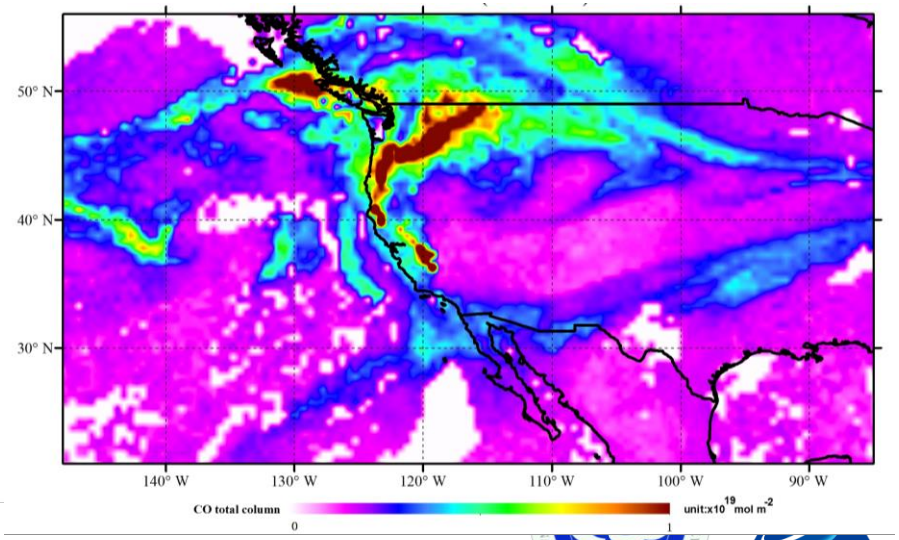


气溶胶指数





CO



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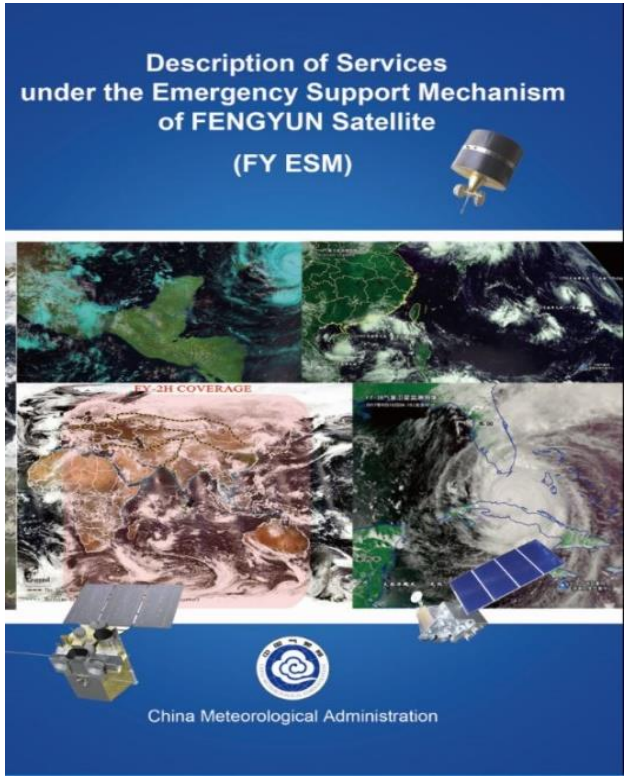
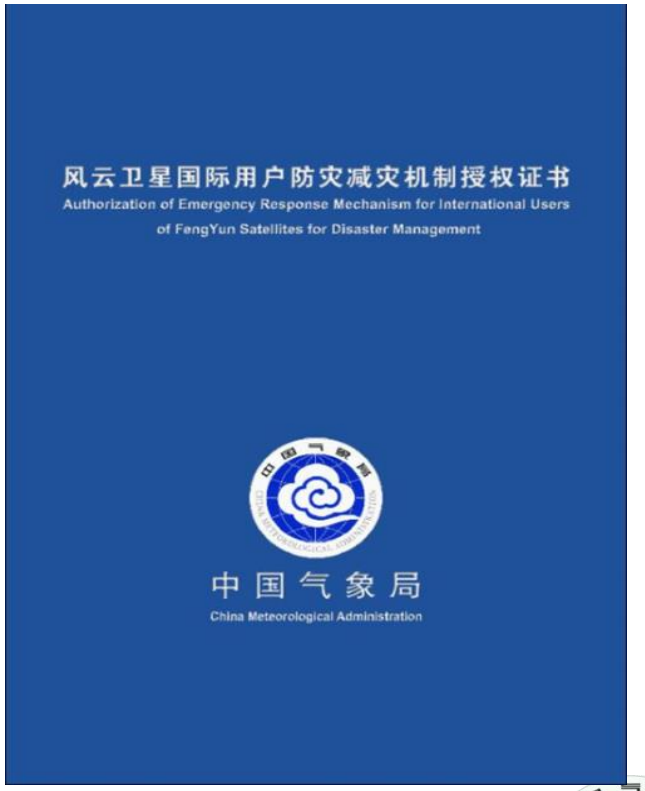
FY-ESM: the Belt & Road Initiative

CMA Announced "Emergency Support Mechanism for International Users of Fengyun Meteorological Satellites in Disaster Prevention and Mitigation" on April 24, 2018





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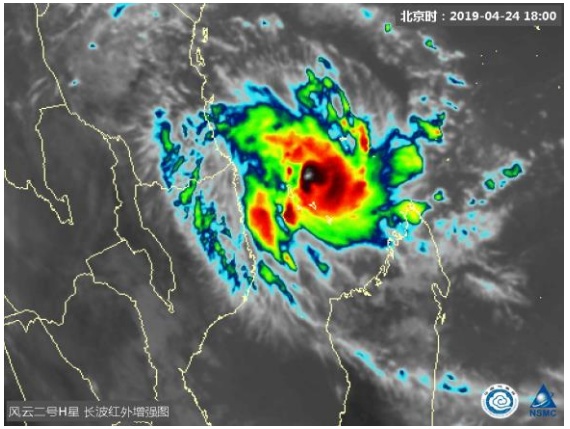
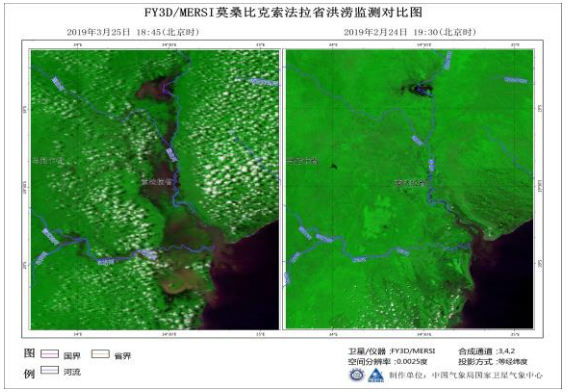
Examples of Emergency support for 9 countries, 2019

Date	Country	Disaster	Requestor
30/01/2019	Brazil	Dam break	China-GEOSS
28/03/2019	Iran	Flood	China-GEOSS
06/04/2019	Korea	Wildfire	CHARTER
25/04/2019	Mozambique	Tropical Cyclone	FY_ESM
28/06/2019	Russia	Flood	CHARTER
21/08/2019	Bolivia	Wildfire	CHARTER
19/09/2019	Mozambique	Early waring	FY_ESM
10/10/2019	India	Flood	CHARTER
14/11/2019	Australia	Wildfire	CHARTER





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2019 FENGYUN Satellite User Conference

- 15-17 November 2019, Haikou
- 37 countries, 78 representatives

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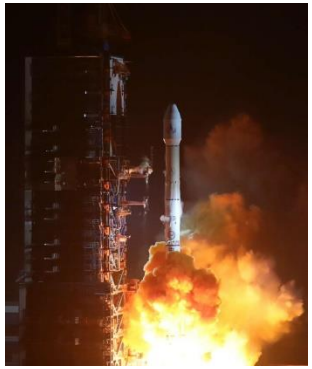
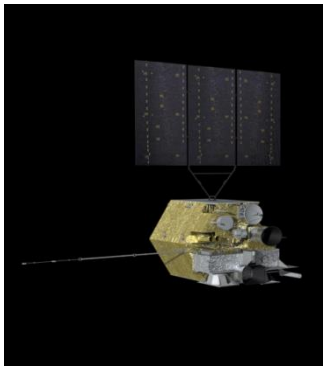
3. Latest Progress

1. **FY-4A The first GEO. meteorological satellite of new generation**
   - Launched on Dec.11, 2016
   - Official operation on May 1, 2018
2. **FY-3D A new operational afternoon orbit LEO. satellite, will co-work with FY-3C in morning orbit**
   - Launched on Nov. 15, 2017.
   - Official operation on Jan 1, 2019
   - Contracted South polar ground station (Troll) in operation
3. **FY-2H The last one of FY-2 series to support IOC and serve for the belt & road countries**
   - Launched on June 5, 2018
   - Official operation on Jan 1, 2019

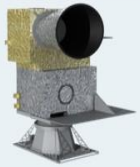
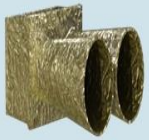
FY-4A: Launched on 11 Dec, 2016





Spacecraft:

1. Launch Weight: approx 5300kg
2. Stabilization: Three-axis
3. Attitude accuracy: 3″
4. Bus: 1553B+Spacewire
5. Raw data transmission : X band
6. Output power: >= 3200W
7. Design life: over 7 years

Instrument		Purposes
	AGRI: Advanced Geosynchronous Radiation Imager	14 -channel Earth images
	GIIRS : Geostationary Interferometric InfraRed Sounder	Clear-sky atmospheric temperature and humidity profiles
	LMI : Lightning Mapping Imager	Lightning distribution map in China area
	SEP: Space Environment Package	Space electric and magnetic environment information

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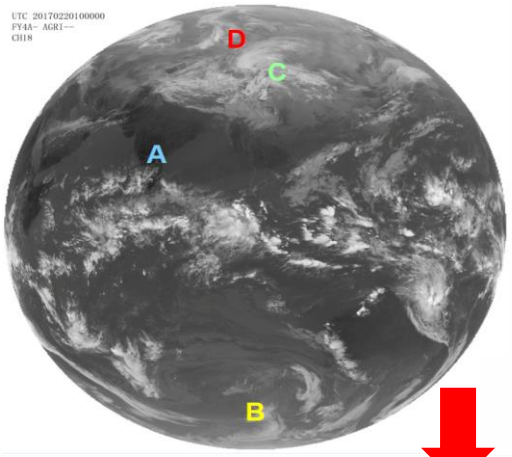
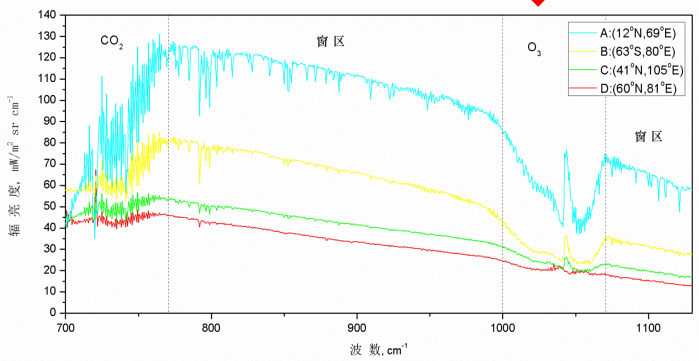
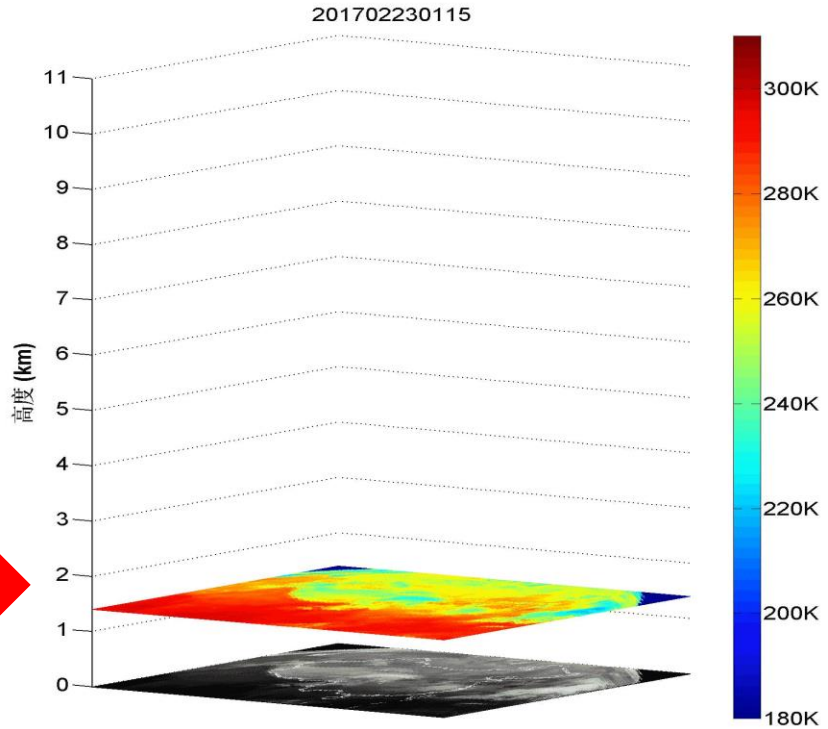
GIIRS:

First Geo. Interferometric Infrared Sounder



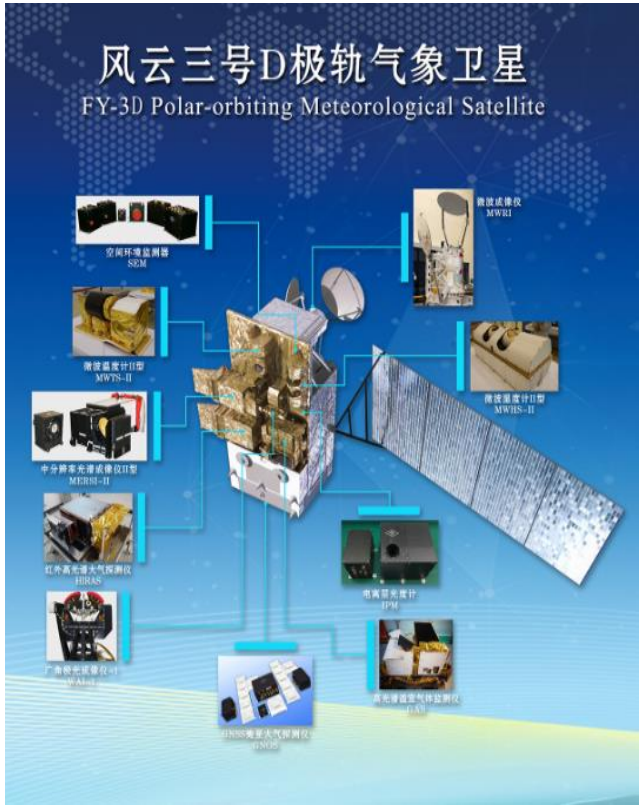




FY-3D: Launched on 15 Nov, 2017

Parameters	Satellite Specification
Orbit type	Near-polar sun-synchronous orbit
Orbital altitude	836 Km
Orbital inclination	98.75°
Precision orbit	Semi-major axis deviation: $\|\Delta a\| \leq 5$Km
	Orbital inclination deviation: $\|\Delta i\| \leq 0.1°$
	Orbital eccentricity ≤ 0.003
Repeat cycle	5.5d (Design range is in 4-10 d)
Eccentricity	≤0.0025
Local time drift at ascending node	15 min within 4 yrs
Launch window	local time at ascending node: 13:40 – 14:00
Design lifetime	5 yrs for design, 4 yrs for assessment

- **Four brand new instruments added (HIRAS, GAS, WAI, IPM)**
- **One Successive instrument updated (MERSI-2)**
- **All the successive Instruments performance are improved significantly**



Payload Name	Channel Numbers with Spectral Coverage
MEdium Resolution Spectral Imager (MERSI-2)	25 (0.413 – 12 μm)
Hyperspectral InfraRed Atmospheric Sounder (HIRAS)	1370 (3.92 – 15.38 μm)
MicroWave Radiation Imager (MWRI)	10 (10.65 – 89 GHz)
MicroWave Temperature Sounder (MWTS-2)	13 (50.3 – 57.29 GHz)
MicroWave Humidity Sounder (MWHS-2)	15 (89.0 – 183.31 GHz)
GNSS Occultation Sounder (GNOS)	29 (--)
Greenhouse-gases Absorption Spectrometer (GAS)	5540 (0.75 – 2.38 μm)
Wide angle Aurora Imager (WAI)	1 (140 – 180 nm)
Ionospheric PhotoMeter (IPM)	3 (130 – 180 nm)
Space Environment Monitor (SEM)	25 (--)

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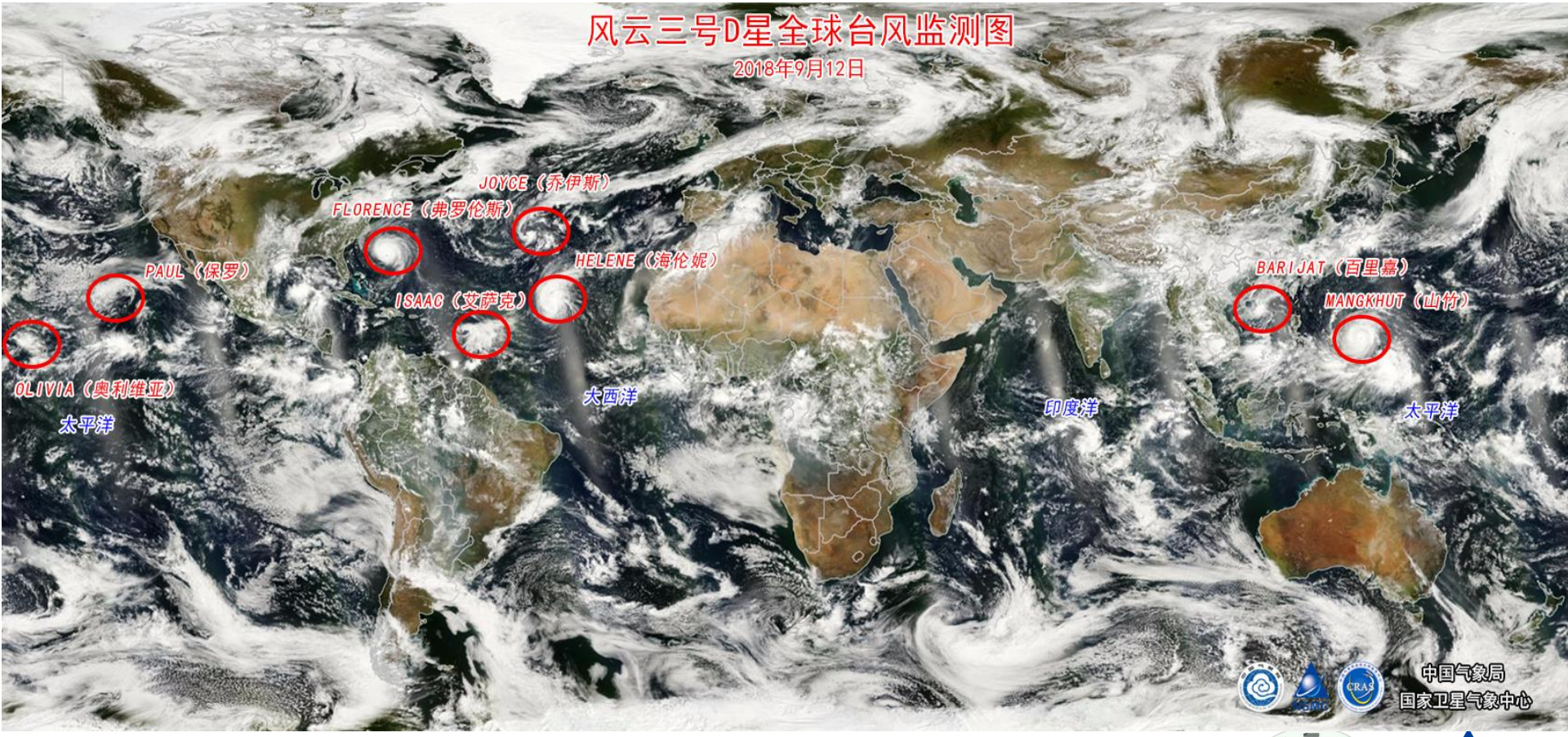
Global Imaging from MERSI



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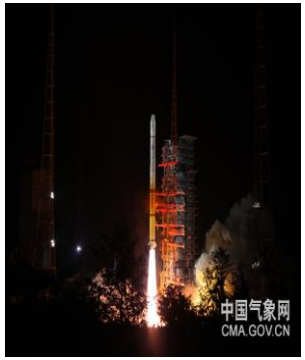
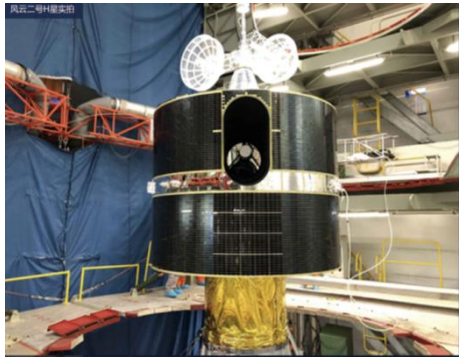
FY-2H: Launched on 5 Jun, 2018

FY-2H： To better support IOC and serve the Belt & Road countries





WMO OMM

World Meteorological Organization
Organisation météorologique mondiale
Organización Meteorológica Mundial
Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
世界气象组织

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Our ref.: 10642/2018/OBS/SAT/FY-2

Ms Liu Yaming
Permanent Representative of China with WMO
China Meteorological Administration (CMA)
46, Zhongguancun Nandajie
BEIJING 100081
China

13 April 2018

Subject: Support to locate the planned launch of FY-2 GEO satellite to cover the Indian ocean

Dear Ms Liu,

I highly appreciate the remarkable achievements and practical benefits that have been made by the Chinese Feng Yun (FY) meteorological satellites in recent years, especially FY-4A, a second generation geostationary meteorological satellite, which was launched in December 2016.

As an important part of the World Meteorological Organization (WMO)'s space program, the FY family not only plays an important role in meteorological disaster risk reduction in China, but also contributes to meteorological forecasting and prediction and disaster management at global and regional levels. In May 2017, China Meteorological Administration (CMA) and WMO signed a letter of intent to promote regional meteorological cooperation and co-build the Belt and Road, in which it was proposed that the two parties would further strengthen the meteorological cooperation with countries and regions along the Belt and Road at the global level in the field of disaster risk reduction and others.

At present, the European geostationary meteorological satellite covering the Indian Ocean is at the end of its life span. In the future, there will be a blank area for the monitoring by geostationary meteorological satellites. WMO is very pleased to note that the satellite coded FY-2/09 is about to be launched this year. It is suggested that CMA consider as much as possible the enhancement of geostationary satellite observation of the above-mentioned region when it conceives the constellation.

I would like to express my appreciation for your continued support in promoting the Programmes and activities of WMO.

Yours sincerely,

(W. Zhang)
for the Secretary-General

- Launched on June 5, 2018
- positioned at 79° E and operational *by September, 2018*

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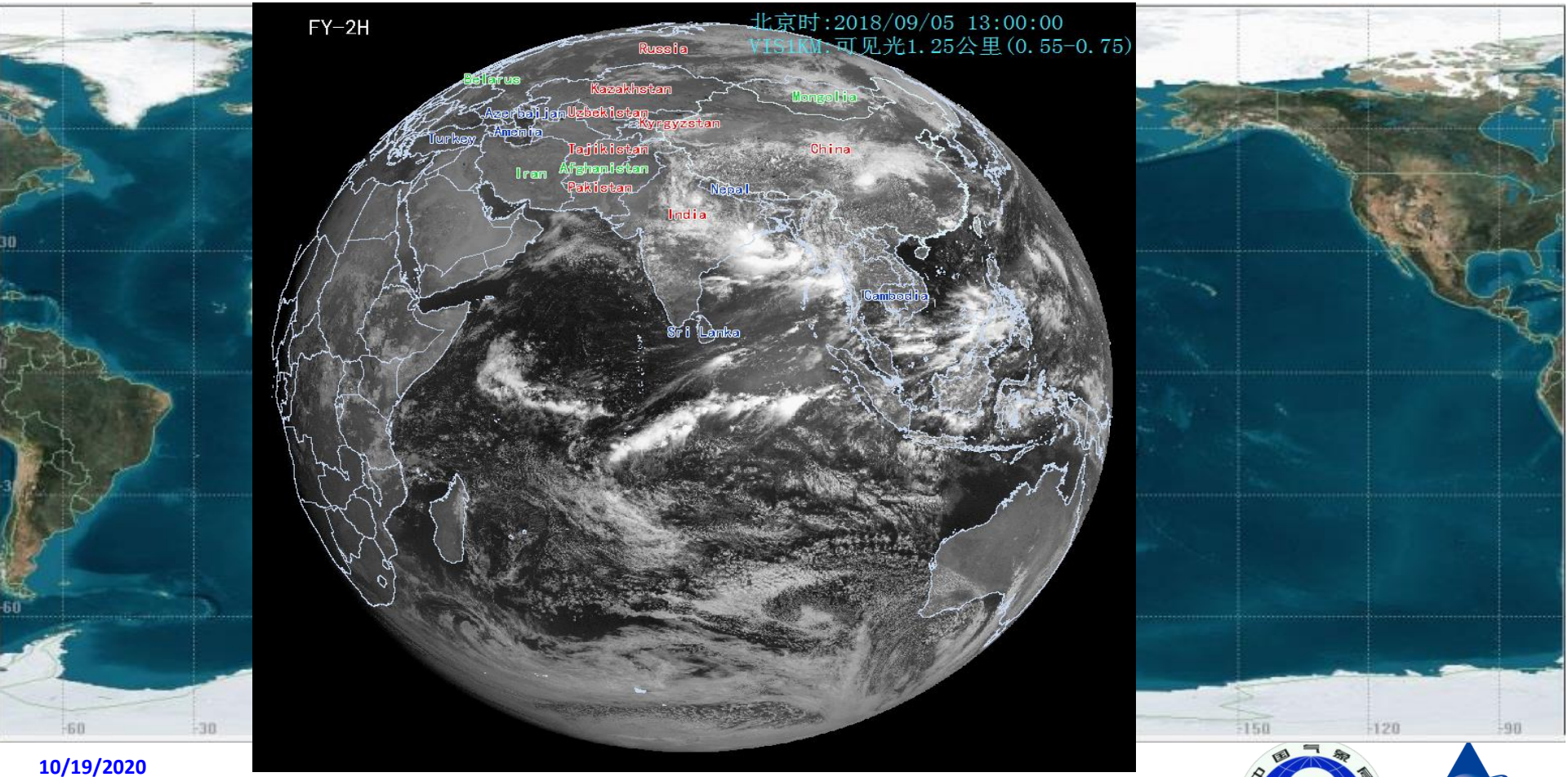
FY-2H coverage at 79° E



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Latest progress on CMA satellite programs

1. **FY-3B**
   - Out of service from Jun. 1, 2020
   - Launched on Nov. 5, 2010

2. **FY-3C**
   - Some instruments on-board FY-3C were forced to suspend for the sake of the energy failure on the satellite platform.
   - Launched on Sep. 23, 2013

3. **FY-3E**
   - Scheduled to be launched on Jan. 2021

4. **FY-4B**
   - Scheduled to be launched on Apr. 2021

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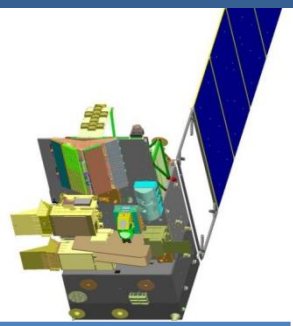
FY-3E



FY-3E satellite instrument configuration

Payloads Type	Instrument Name	Remarks
Optical imager	MERSI-LL	Improved
Passive microwave sounder	MWTS	Improved
	MWHS	succeed
IR Hyper-spectral Sounder	HIRAS-II	Improved
Active microwave	Wind RAD	New
Radio occultation instrument	GNOS	Improved
Solar Radiation observation package	SIM-II	Improved
	SSIM	New
Space weather package	SEM	Improved
	Ionospheric spectrometer	Improved
	XEUVI	New

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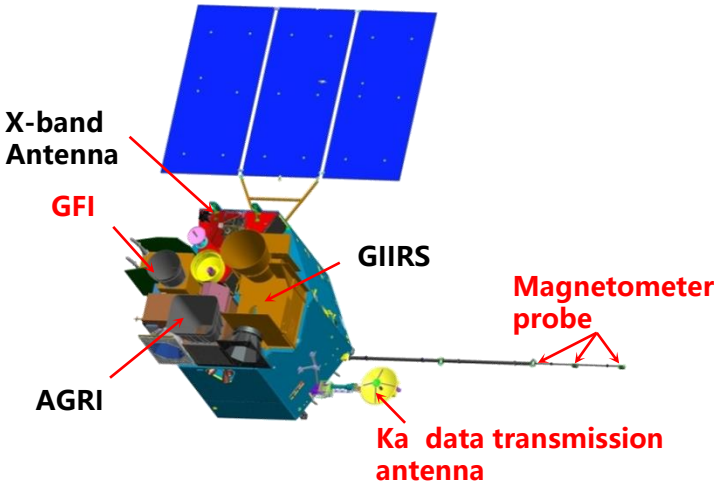
FY-4B



satellite	Scheduled launch	Planned Location	Instruments
FY-4B	Apr. 2021	105°E	AGRI GIIRS GFI SEP

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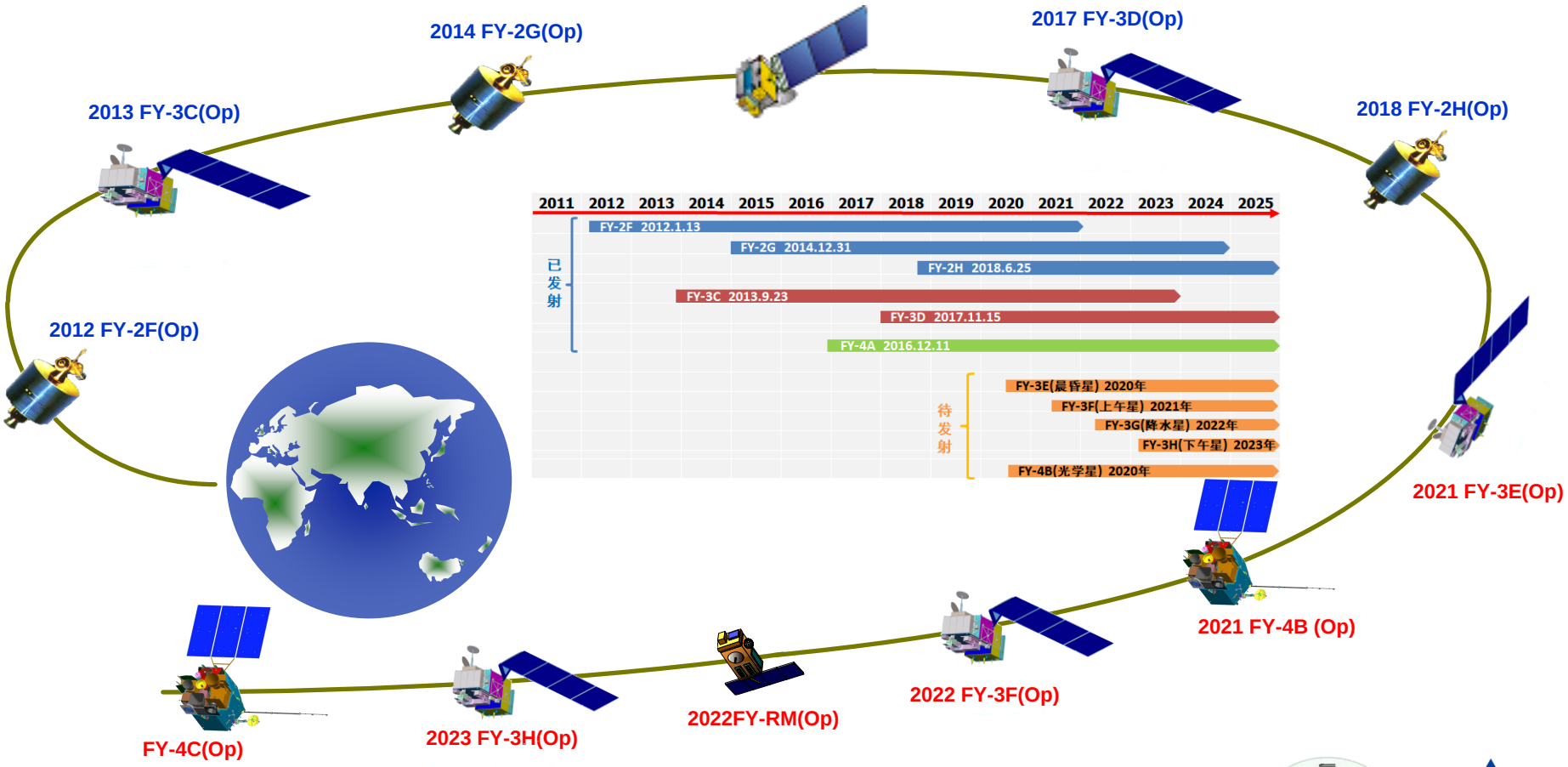
4. Future Program

National Program for Fengyun Meteorological Satellite from 2011-2020



- 6 satellites will be launched within this decade

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Payloads Coming FY-3 Successor

N0.	Sensor	Satellite / Sensor	FY-3E (05) EM Satellite	FY-3F (06) AM Satellite	FY-3R (07) Rainfall Satellite	FY-3G (08) PM Satellite
		Scheduled Launch Date	2021	2022	2022	2023
1	Optical Imagers	**MERSI**	√（III-Low Light）	**√（III）**	√（III-Simplified）	**√（III）**
2	Passive Microwave Sensors	MWTS	√	√		√
		MWHS	√	√		√
		MWRI		√	√	√
3	Occultation Sounder	GNOS	√	√	√	√
4	Active Microwave Sensors	WindRAD	√	√		
		Rainfall RAD			√	
5	Hyperspectral Sensors	**HIRAS**	√	√		√
		GAS (Greenhouse Gases Absorption Spectrometer)				√
		OMS (Ozone Mapping Spectrometer)		√		
6	ERB Observation Sensor Suite	ERM		√		
		SIM	√	√		
		SSIM (Solar Spectral Irradiation Monitor)	√			
7	Space Weather Sensor Suite	SEM	√			
		Wide Angle Aurora Imager				√
		Ionosphere photometer	√(Multi-angle)			**√**
		Solar X-EUV Imager	√			

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Future additional satellite	Scheduled launch	Planned Location	Instruments
FY-4C	2022	TBD	AGRI GIIRS LMI SEP MUSI SUVI SXUS

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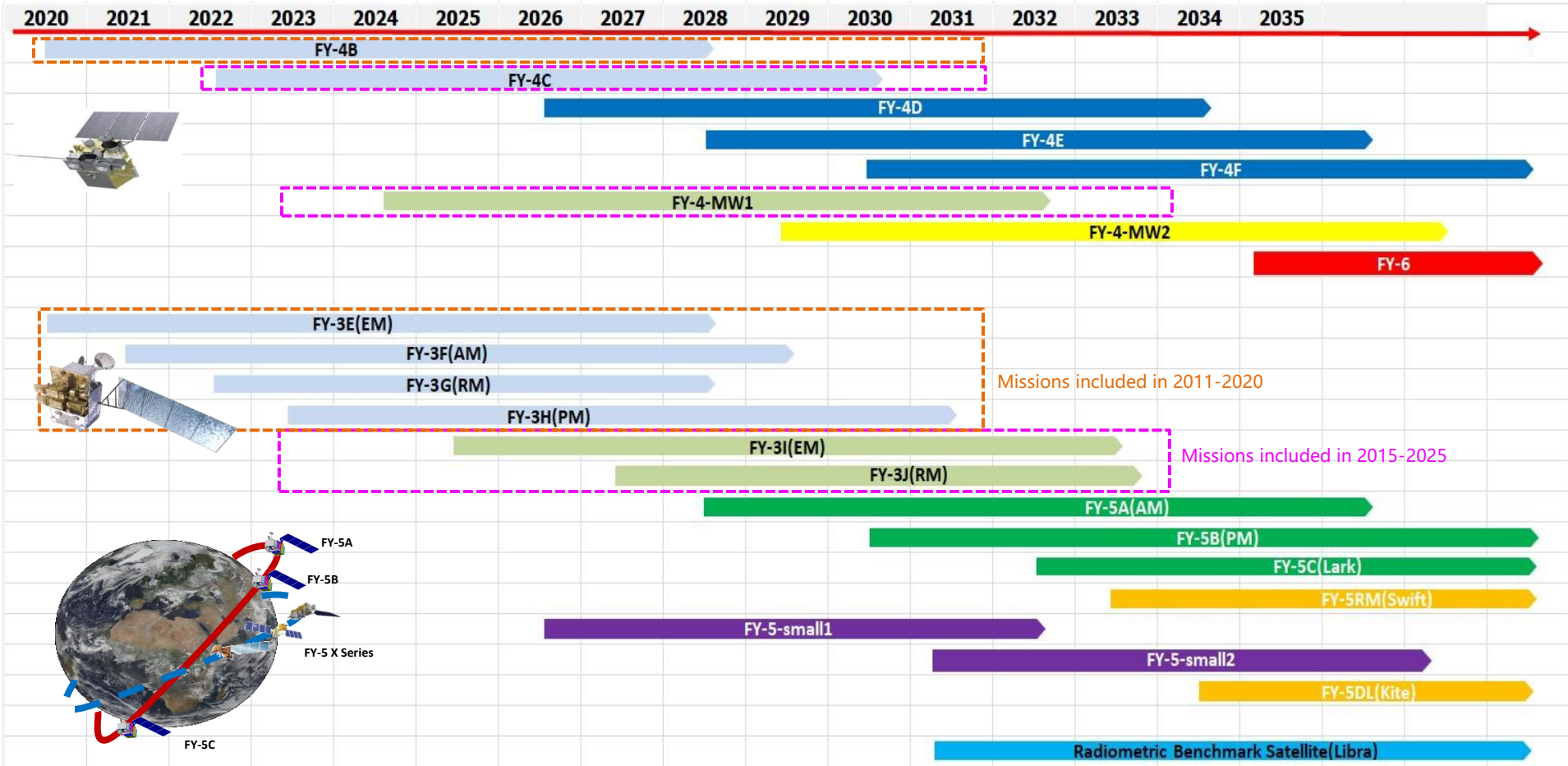
Vision for Future Fengyun in 2035



10/19/2020

Lark series: EM Orbit (Optimal sounding mission, 5:30 am)

- **Mission description:** Fill in the gap of NWP sounding in Early morning orbit for composing global virtual constellation with METOP(AM) & JPSS (PM)
- **Application:** NWP
- **Major sensors:**
  - IR hyperspectral sounder
  - MW sounder
  - Scatterometer
  - GNSS radio occultation

PM Orbit (2:30 pm)

- **Mission description:** Imaging +sounding mission
- **Application:**
  - Meteorological & environment disaster
  - Ecological environment
  - NWP
- **Major sensors:**
  - VIS/IR imagery
  - MW imagery
  - IR hyperspectral sounder
  - MW sounder
  - GNSS radio occultation

10/19/2020

Fengyun 5: 3rd generation polar satellites

AM Orbit (10:30 am)

- **Mission description:** Imaging and cloud/aerosol measurement
- **Application:**
  - climate
  - Meteorological & environment disaster
  - Ecological environment
- **Major sensors:**
  - Lidar
  - Cloud radar
  - VIS/IR multi-angle imagery
  - MW imagery
  - Sub-mm imagery
  - UV/VIS/NIR sounder (nadir & limb)

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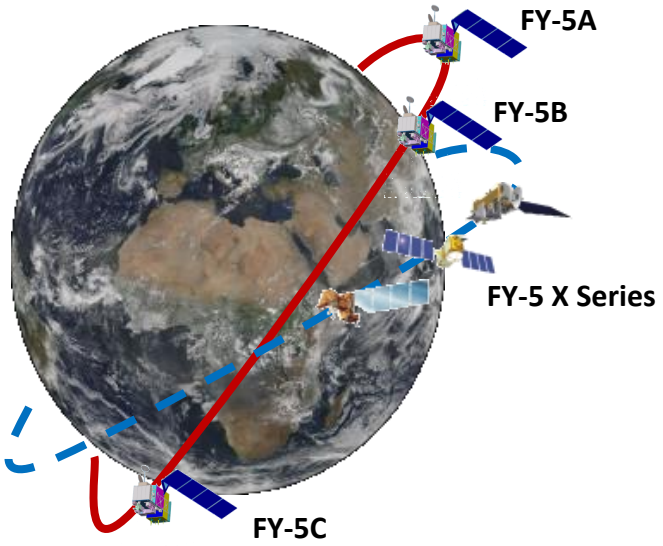
Vision for Future Fengyun in 2035

- Consistent with WIGOS in 2040 for the space-based observing system component, an integrated observing system of Fengyun weather and climate satellites will be established by 2040, which is a backbone system with specified orbital configuration and measurement approaches, will fill in the blanks of space-based profiling of global wind as atmospheric dynamical fields, climatic variables, fill in the gaps of spatial and temporal coverage by optimizing the constellation configuration, promote space/ground co-observing capability to better meet the requirements for emergency response to meteorological disasters.
- The Radiometric Benchmark Satellite mission aiming to establish stable and traceable space calibration reference will be developed as well.



- A backbone system with open orbit configuration and flexibility to optimize the implementation will be developed, which is composed of some small/ large satellites programs for dedicated-objective mission with the capabilities of higher temporal and spatial resolution and fast sampling, global cloud, aerosol, wind etc. dedicated observation, to meet the requirements of weather forecasting, meteorological risk reduction and emergency response promotion.
- Furthermore, the operational pathfinders, technology and science demonstrators will be explored to respond to R&D needs.

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5. Summary

- With the open data policy, reliable and sustained satellite, good data accuracy, FY series have be one important components of global observation system.
- Current FY-3 series are expected to work until 2030 with Early Morning orbit, Morning orbit, and Afternoon orbit and Rainfall mission.
- Current FY-4 series are expected to work until 2035 with FY-4 East (133E) and FY-4 West (79E).
- Future FY-5 and FY-6 are expected to provide service since 2030 and 2035 respectively.
- Fengyun Meteorological Satellites will contribute to WMO members and serve the belt and road countries operationally and continuously.


Together
For Better
谢
谢！